DEPARTMENT OF ECOLOGY
State of Washington

Technical Support Document for The Boeing Company PSD 14-01, Amendment 4 Boeing Everett, 777X Project

April 2021

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Air Quality Program

Washington Department of Ecology

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1. Executive Summary

Boeing Everett applied to change their Prevention of Significant Deterioration (PSD) permit to revise the VOC limit of the wing component fabrication operation. This revision is to account for period of low production rate that was not anticipated in the original approval.

The proposed changes will not increase volatile organic compound (VOC) emissions from the wing component fabrication operation and the original "777X" project.

The Boeing Everett facility manufactures commercial aircraft, specifically models 747, 767, 777, and 787. The facility is located at 3303 West Casino Road in Everett. The area that is designated as meeting national air quality standards (in attainment or unclassifiable).

After reviewing Boeing's request, Ecology proposes to approve this request. This technical support document shows Ecology's analysis supporting our decision.

2. Site and Project Description

2.1. Site description

The Boeing Everett facility manufactures model 747, 767, 777, and 787 commercial aircraft. The facility is located at 3303 West Casino Road, Everett, Washington, which is in a Class II area that is designated as "attainment or unclassifiable" for the purpose of PSD permitting for all pollutants.

The facility is a major stationary source for PSD purpose due to potential volatile organic compounds (VOCs) emission higher than 250 tons per year.

2.2. Project description

Boeing is proposing to revise Condition V.A.5 of PSD 14-01, A3 to account for VOC emission during low production period. The existing Condition V.A.5 of the permit is as shown below.

"**VOC emission from 777X wing component fabrication operations in Building 40-58 must not exceed 1.73 tons per completed shipset of 777X wing components, on a 12-month rolling average**."

Boeing explains that during period of low production rate, it could be months when there are no completed shipsets produced while the VOC emissions from fabrication of various wing components are being added to the VOC emission on 12-month rolling average. However, during the low production period, Boeing is facing a unique challenge where there is no completed shipsets to add to the denominator of the calculation.

Therefore, Boeing is proposing to establish a higher VOC limit for wing component fabrication operations during low production period.

The proposed changes will not increase the VOC emission from the wing component fabrication operation and the overall VOC emission from the "777X" project.

3. PSD Permit Revision Review

3.1. Overview and permitting history

3.1.1. "777X" project PSD permitting history

Permit No.	Issuance Date	Project Description
14-01	9/10/14	Described as the "777X" project. The project allows for transition from production of the traditional 777 models to 777X models and increases the maximum production capacity. The project has significant net emission of VOCs.
14-01, Amendment 1	12/9/15	To install additional units following the original permit, which include a wing spar booth, three small paint mix booths, two coating equipment cleaning booths, and one emergency diesel generator.
14-01, Amendment 2	1/18/19	Administrative amendment. To allow for coating of small wing parts in three existing booths in the 40-51 Building instead of in the paint hangers.
14-01 Amendment 3	12/20/19	To increase the flow rate of the prep booths and allow for coating operation in the wing panel prep booths.

3.1.2. Revision to PSD permit

Condition V.A.5 of the permit consists of VOC limit applies to the wing components fabrication for "777X" project. Boeing is requesting to include a higher VOC limit during low production period.

Ecology finds that this revision does not meet the administrative revision as described in WAC 173-400-750 (3) and therefore subject to mandatory public involvement requirements.

3.1.3 Description of wing component fabrication operation

The wings of the 777X will be primarily made of composite material. The main wing components that will be made of composite material include upper and lower panels, front and rear spars, and upper and lower panel stringers. The manufacturing process of each of these parts is similar and involves the following steps:

• Wing component layup

• Curing in an autoclave

• Trimming and drilling

• Washing

• Non-destructive inspection

• Preparation for priming (e.g., abrading, solvent cleaning)

• Priming

• Wing component build-up

VOC emissions are generated from all of steps above.

Part layup: Part layup involves the manual or automated layup of composite material (in the form of resin pre-impregnated tape or sheets) onto a mandrel which is preformed into the shape of the part being fabricated. Emissions associated with the part layup primarily occur from preparing the mandrel prior to the actual part layup process. Preparing the mandrel involves cleaning the surface with solvent, applying a mold release compound, and applying a tackifier solution.

Wing component cleaning: Open floor emissions from wipe cleaning primarily occur during the part buildup process, but can occur throughout the manufacturing process.

Sealing and touch up coating: Open floor emissions from the application of sealant and miscellaneous coatings will primarily occur during the part buildup process, but can occur throughout the manufacturing process. Most of the coating of the wing components will take place in the spray booths and will not result in open floor emissions.

3.1.4. The VOC estimation from Table A-2 of the original 777X project application

What is a Shipset?

A shipset from the standpoint of the 777X wing component fabrication operation in the Building 40-58 Composite Wing Center means the total quantity of wing components that must be fabricated to make the left and right wings of a single airplane. The wing components fabricated in Building 40-58 that make up shipset include two upper and two lower wing panels, two front and two rear spars, and a total of 86 upper and lower panel stringers.

How the VOC emissions from Wing Components Fabrication Operation were estimated?

In principal, the VOC emissions were estimated based on material balance method with the knowledge of potential usage rate of each VOC containing material in the operation and the VOC content from the safety data sheet (SDS).

More details about emission estimation can be found in Table A-2, Appendix A of the original 777X project application. However, for the purpose of this review and discussion, some of the information are summarized and presented below in order to show how the VOC emission limit in Condition V.A.5 of the permit was estimated and established.

EU or Activity Identifier	EU or Activity Description	Non-combustion VOC Emission per Shipset
WCF - 1	Prep of layup mandrels (cleaning and application of mold release, tackifier (if req'd), and tooling filler (if req'd))	1,552 lb VOC/shipset
	Wing panel buildup (shop floor emissions from hand-wipe cleaning, sealing, touchup coating, and other miscellaneous activities)	190 lb VOC/shipset
	Wing spar buildup (shop floor emissions from hand-wipe cleaning, sealing, touchup coating, and other miscellaneous activities)	153 lb VOC/shipset
	Total =	1,895 lb VOC/shipset
WCF - 4	Vacuum pump(s) servicing autoclaves (2 per autoclave, or 6 vacuum pumps total)	114 lb VOC/shipset
WCF - 5	Dust collector used to collect particulates from trimming, drilling, and other machining operations on cured components	0
WCF-6a	Wing panel wash stall #1	0- SDS states that VOC content is zero.
WCF-6b	Wing panel wash stall #2	0-SDS states that VOC content is zero.
WCF-6c	Wing spar and stringer wash stall #1	0-SDS states that VOC content is zero.
WCF-6d	Wing spar and stringer wash stall #2	0-SDS states that VOC content is zero.
WCF-7	Gas-fired plasma unit for treatment of wing panel stringer	NA
WCF-8a	Wing panel prep booth #1	504 lb/shipset
WCF -8c	Wing panel prep booth # 2	
WCF-8b	Wing spar prep booth	70 lb/shipset
WCF-9a	Wing panel spray booth # 1	818 lb/shipset
WCF-9b	Wing panel spray booth # 2	818 lb/shipset
WCF-9d	Wing panel spray booth # 3	818 lb/shipset
WFC-9c	Wing spar spray booth	118 lb/shipset
WCF-10a	Wing panel primer curing booth #1	53 lb/shipset
WCF-10b	Wing panel primer curing booth #2	
WCF-10c	Wing spar primer curing booth	7.7 lb/shipset
WCF-11	Small quantify paint mix booth	>1 lb/shipset

EU or Activity Identifier	EU or Activity Description	Non-combustion VOC Emission per Shipset
WCF-12a	Coating equipment cleaning booth #1	32 lb/shipset
WCF-12b	Coating equipment cleaning booth #2	
WCF-14	Wing spar seal booth	152 lb/shipset
Total		**3,763 lb/shipset**

The 1.73 tons/shipset limit was derived by subtracting the VOC emission estimate for the wing spar seal booths (152 lb/shipset - see Emission Unit/Activity ID # WCF-14 in Table A-2) and for the wing spar buildup process (153 lb/shipset - see Emission Unit/Activity ID WCF-1 in Table A-2) from the 3763 lb/shipset value since those two emission units/activities do not occur in Building 40-58.

3.1.5 Boeing's proposed permit revision

Boeing Everett has proposed to revise Condition 5 of the permit as shown below.

5. VOC emission from 777X wing component fabrication operations in Building 40-58 must not exceed:

a) 1.73 tons per completed shipset of 777X wing components, on a 12-month rolling average **when the total number of 777X wing component shipsets completed in Building 40-58 over the previous twelve (12) consecutive months is at or above 12 shipsets**, or;

b) **3.85 tons per completed shipset of 777X wing components, on a 12-month rolling average when the total number of 777X wing component shipsets completed in Building 40-58 over the previous twelve (12) consecutive month is below 12 shipsets."**

Boeing explains that Condition V.A.5 poses a unique challenge during periods of low production rates as it often takes months to fabricate a complete shipset of 777X wing components yet more than one shipset of 777X wing components are typically in the process of being fabricated at the same time. For example, during the 7 month period between October 2020 and April 2021, Boeing anticipates fabricating just two complete shipsets. However, during that same time period, portions of nine or more shipsets will be in the process of being fabricated.

So for the months when there are no completed shipsets produced, there are still VOC emissions from the fabrication of various wing components from multiple different shipsets. In calculating the 12-month rolling average VOC emissions per shipset as per Condition VIII.D.4 of the PSD, these VOC emissions add to the numerator of the formula for determining compliance with the per shipset emission limit but there are no completed shipsets to add to the denominator. As a result, with only increases in numerator without addition to the denominator, mathematically, it could potential result in an exceedance of the permitted limit. Such an exceedance, if it were to

occur, is not due to any malfunction of air pollution control equipment, process equipment, or of a process but rather, is due to the reasons explained above.

In the November 25, 2020, email, Boeing further explained that even though Boeing could potentially revise the formula to allow for partial shipsets, this may still not solve the problem as the VOC emissions from producing different wing components are quite different. In addition, it would impose a significant additional data collection burden without environmental benefits (e.g., for each shipset in production in a particular month, Boeing would need to track all 94 individual production parts that make up a shipset and their state of completion at the end of the month).

Therefore, Boeing proposes a second VOC limit of 3.85 tons per shipset be established for periods when production is below 12 completed shipsets in any consecutive 12 months period. This proposed limit was arrived at as follows:

1. Boeing first determined that the highest monthly VOC emissions in any calendar month in 2020 was 2855 lb and occurred in February 2020 (a month in which we also happened to have no completed shipsets).

2. Boeing then assumed that the VOC emissions for each calendar month from October 2020 through September 2021 would be the same as the VOC emissions in February 2020.

3. Boeing used production planning information to project the total number of shipsets that will be completed each month from October 2020 through September 2021.

4. Finally, Boeing calculated the 12-month rolling average VOC emissions per completed shipset for the 12 months ending October 2020 through September 2021 (emissions from October 2020 through September 2021 were projected emissions) using the above assumptions/projections and the actual monthly VOC emissions and shipset data previously compiled for October 2019 through September 2020. Boeing found that that the 12-month rolling average VOC emissions per shipset would peak in July 2021 at 3.21 tons. Because of the uncertainty associated with estimating future VOC emissions, Boeing added a 20 percent risk buffer to the estimate, which increased the proposed limit to 3.85 tons per shipset.

	Oct_19	Nov_19	Dec_19	Jan_20	Feb_20	Mar_20	Apr_20	May_20	Jun_20
Rolling 12-Month 14-01 CWC VOC Total (lbs):	29820	29966	30472	30937	29953	29471	26407	23474	22959
Rolling 12-Month 14-01 CWC VOC Total (tons):	14.9	15.0	15.2	15.5	15.0	14.7	13.2	11.7	11.5
Rolling 12-Month 14-01 CWC VOC per shipset (Tons per complete shipset):	1.49	1.50	1.39	1.41	1.50	1.47	1.65	1.30	1.43

	Jul_20	Aug_20	Sep_20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21
Rolling 12-Month 14-01 CWC VOC Total (lbs):	23949	22709	23572	24034	24899	26233	26938	26938	27692
Rolling 12-Month 14-01 CWC VOC Total (tons):	12.0	11.4	11.8	12.0	12.4	13.1	13.5	13.5	13.8
onth 14-01 CWC VOC per shipset (Tons per complete shipset):	1.33	1.42	1.3	1.2	1.4	1.6	1.9	1.7	2.0

	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21
Rolling 12-Month 14-01 CWC VOC Total (lbs):	29514	31618	31779	32107	33153	34260
Rolling 12-Month 14-01 CWC VOC Total (tons):	14.8	15.8	15.9	16.1	16.6	17.1
onth 14-01 CWC VOC per shipset (Tons per complete shipset):	2.1	2.3	2.6	3.2	2.8	2.9

The wing component fabrication operation was treated as "new" in the original application. The emission increase was based on the potential emission rate, which was estimated to be 235 tons VOC/year. For the proposed limit, if the operation produced 12 shipset per year, the potential VOC emission will be approximately 46.2 tons per year. Therefore, while Boeing requested for higher VOC limit for wing component fabrication operation, the request is due to unforeseen low production rate that affect how compliance can be demonstrated mathematically. The VOC limit cannot be achieved in practice when the production rate during 12-consecutive month is below 12 shipsets.

After the review, Ecology finds that Boeing Everett has provided clear reasonable basis for the permit revision and hereby approves the request.

3.1.6 Other updates

Boeing also provided an update regarding the units that have been installed, the units that are not yet installed (NYI) but still could be installed and the units that will not be installed. The units that will not be installed have been removed from the permit. These changes are reflected in the permit.

Unit ID	Equipment Description	New or Modified	Updates
WCF-2	Gas fired heater for liquid nitrogen vaporization unit	New	Gas-fired heater will not be not installed. Instead, steam from an existing boiler is used to vaporize the liquid nitrogen.
WCF-3a	Gas-fired process heater for autoclave #1	New	Installed
WCF-3b	Gas-fired process heater for autoclave #2	New	Installed
WCF-3c	Gas-fired process heater for autoclave #3	New	NYI
WCF-4	Vacuum pump(s) servicing autoclaves	New	Installed
WCF-6a	Wing panel wash stall #1	New	Installed
WCF-6b	Wing panel wash stall #2	New	NYI
WCF-6c	Wing spar wash stall	New	Spar and stringer wash stalls are separate units.
WCF-6d	Wing stringer wash stall	New	Spar and stringer wash stalls are separate units.
WCF-7	Gas-fired plasma unit for treatment of wing panel stringers	New	NYI
WCF-8a	Wing panel prep booth #1(abrasive blast/sanding, solvent hand-wipe, edge seal and non-chromate coating application)	New	Installed

Unit ID	Equipment Description	New or Modified	Updates
WCF-8b	Wing spar prep booth (abrasive blast/sanding, solvent hand-wipe, edge seal)	New	NYI
WCF-8c	Wing panel prep booth #2 (abrasive blast/sanding, solvent hand-wipe, edge seal, and non-chromate coating application)	New	Installed
WCF-9a	Wing panel spray booth #1	New	Installed
WCF-9b	Wing panel spray booth #2	New	Installed
WCF-9d	Wing panel spray booth #3	New	NYI
WCF-9c	Wing spar spray booth #1	New	NYI
WCF-9e	Wing spar spray booth #2	New	NYI
WCF-10a	Wing panel primer curing booth#1	New	Will not be installed – cure occurs in spray booth.
WCF-10b	Wing panel primer curing booth#2	New	Will not be installed – cure occurs in spray booth.
WCF-10c	Wing spar primer curing booth	New	Will not be installed – cure occurs in spray booth.
WCF-11a	Small quantity paint mix booth #1	New	Installed
WCF-11b	Small quantity paint mix booth #2	New	Installed
WCF-11c	Small quantity paint mix booth #3	New	NYI
WCF-11d	Small quantity paint mix booth #4	New	NYI
WCF-12a	Coating equipment cleaning booth #1	New	Installed
WCF-12b	Coating equipment cleaning booth #2	New	Installed
WCF-12c	Coating equipment cleaning booth #3	New	NYI
WCF-12d	Coating equipment cleaning booth #4	New	NYI
WCF-14	Up to four (4) Wing Spar seal booth (s)	New	Will not be installed
WBSP-1a	Robotic wing spray booth for left hand wing	Modified	Installed
WBSP-1b	Robotic wing spray booth for right hand wing	Modified	Installed
WBSP-2	Forward body section spray booth	Modified	Installed
WBSP-3	Mid body section spray booth	Modified	Installed
WBSP-4	Aft body section spray booth	Modified	Installed
WBSP-6	Forward body section corrosion-inhibiting compound spray booth	Modified	Installed
WBSP-7	Mid body section corrosion-inhibiting compound spray booth	Modified	Installed

Unit ID	Equipment Description	New or Modified	Updates
WBSP-8	Aft body section corrosion-inhibiting compound spray booth	Modified	Installed
WBSP-10	Vertical fin hybrid laminar flow control prep booth	New	NYI
WBSP-11a	Vertical fin hybrid laminar flow control spray booth #1	New	NYI
WBSP-11b	Vertical fin hybrid laminar flow control spray booth #2	New	NYI
WBSP-11c	Vertical fin hybrid laminar flow control spray booth #3	New	NYI
AA-2a	Wing stub spray coating enclosure #1	New	Installed
AA-2b	Wing stub spray coating enclosure #2	Modified	Installed
F-1	Combustion equipment for comfort or process heating not otherwise identified elsewhere in this table; multiple units, most of which will be less than 5 MMBtu/hr, and all of which will be less than 10 MMBtu/hr	New	Installed
F-2a	Up to nine (9) 2,750-kW diesel generators	New	NYI
F-2b	Up to two 750-kW diesel generators	New	Installed
IRC-1a	Paint spray booth #1	New	Installed
IRC-1b	Paint spray booth #2	New	Installed
IRC-1c	Paint spray booth #3	New	Installed
IRC-2	Paint spray booth #4	New	Installed
IRC-3	Crushed core press	New	NYI

6. State Environmental Policy Act

State Environmental Policy Act (SEPA) review for the expansion of the Boeing Everett site for the 777X Project, including the new 777X Composite Wing Center in which the wing panel prep and spray booths are located, has already been addressed in the following two documents:

1. SEPA Addendum #1 (Revised), Southwest Everett Planned Action EIS, SEPA #13-019
2. Addendum No. 15 to the 1991 Boeing Everett Mitigation Decision Document, SEPA #14-011

Ecology concludes that the applicant has adequately demonstrated compliance with SEPA requirements.

7. Environmental Justice Review

Environmental Justice (EJ) is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Ecology conducts an EJ review to ensure no group of people bear a disproportionate share of the negative environmental consequences as the result of the permitting action.

Because the project will not have any emission increase, Ecology did not conduct more extensive review of the potential for disproportionate high and adverse effects on an EJ community.

Ecology also determines that an enhance outreach effort is not needed due to the nature and scope of this project.

8. Public Involvement

This PSD permitting action is subject to a minimum 30-day public comment period under WAC 173-400-740. Ecology posts the public notice on Ecology's web site for a minimum of 30 days. Day one of the public comment period begins on the next calendar day after Ecology posts the public notice.

No comments were received during the public comment period.

9. Agency Contact

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Acronyms and Abbreviations

BACT	Best Available Control Technology
CARB	California Air Resources Board
cfm	cubic feet per minute
CFR	Code of Federal Regulations
Ecology	Washington State Department of Ecology
EJ	Environmental Justice
EPA	United States Environmental Protection Agency
g	gram(s)
gal	gallon(s)
HVLP	high volume low pressure
L	liter(s)
lb	pound(s)
MACT	maximum achievable control technology
NAAQS	National Ambient Air Quality Standards
PSD	Prevention of Significant Deterioration
PTE	potential to emit
RBLC	RACT/BACT/LAER Clearinghouse
SEPA	State Environmental Policy Act
SER	significant emission rate
SIP	State Implementation Plan
tpy	tons per year
TSD	technical support document
VOC	volatile organic compound
WAC	Washington Administrative Code